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AUTHOR	Doyle, Maureen
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ABSTRACT

This qualitative case study examines the use of teacher leaders to support fellow teachers in the implementation of a standards-based mathematics curriculum. Empirical and theoretical research advocate that teacher leaders need to internalize and embody seven interdependent leadership roles in order to create real and sustained change. Data were collected via observations and interviews with two elementary teacher leader and classroom teacher pairs. Findings from this study show that four teacher leaders from two schools supported classroom teachers by providing administrative resource support and acting as a conduit for communication between teachers and district leaders. When additional funding was available from an outside grant, teacher leaders from one school embodied additional leadership functions of providing instructional and content knowledge support and developing mentoring relationships with teachers. The organizational structure provided by the outside grant enabled teachers and teacher leaders to examine good teaching practices in a mathematics classroom. As a result, teacher leaders from the funded school were able to provide instructional support as well as managerial support. Appended are: the conceptual framework, guiding questions for teacher leaders and classroom teachers, and the coding scheme. (Contains 76 references.) (SM)

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Making Meaning of Teacher Leadership in the Implementation of a Standards-based Mathematics Curriculum

Maureen Doyle

University of Washington

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Abstract

This qualitative case study examines the use of teacher leaders in supporting fellow teachers in the implementation of a standards-based mathematics curriculum. Empirical and theoretical research advocate that teacher leaders need internalize and embody seven interdependent leadership roles in order to create real and sustained change. Findings from this study show that four teacher leaders from two schools supported classroom teachers by providing administrative resource support and acting as a conduit for communication between teachers and district leaders. When additional funding was available from an outside grant, teacher leaders from one school embodied additional leadership functions of providing instructional and content knowledge support and developing mentoring relationships with teachers. The organizational structure provided by the outside grant enabled teachers and teacher leaders to examine good teaching practices in a mathematics classroom. As a result, teacher leaders from the funded school were able to provide instructional support as well as managerial support.

Introduction

School districts all over the country are grappling with how to respond to more demanding standards in mathematics education. Problems surrounding this issue include: increasing students' achievement in mathematics, adopting or adapting mathematics curricula that reflect their state's new academic standards, and enhancing teachers' mathematical content and pedagogical content knowledge in order to respond to the new academic standards. In response to these demanding issues, a school district in Washington State adopted the Technical Educational Research Center (TERC) mathematics reform curriculum Investigations in Number, Data and Space (Investigations) for elementary grades. The adoption of TERC's Investigations was the next progression in a line of curriculum changes. Before this adoption, some teachers used Marilyn Burns' replacement units and many teachers used a traditional instructional approach for teaching mathematics with the adoption of Investigations. In using this elementary mathematics curriculum teachers are asked to present mathematical concepts through problem solving and inquiry, requiring teachers to have deeper understandings of the concepts they are teaching. Further, they must decide most of their instructional moves based on interpretation of their students' understanding of the subject material (Ferrini-Mundy, 1996). To successfully implement this new mathematics curriculum and its mathematical pedagogy, many teachers need support and guidance.

To bring lasting reform to mathematics education, professional development opportunities, local leadership, and sustained support mechanisms are needed at the district and school level (Fullan, 1991). Sikes (1992) claimed that teacher leaders are the strongest link for transforming teaching practices, because they can offer local leadership and provide the support mechanisms needed at the school level. The Washington school district studied here assisted its elementary teachers in the implementation of Investigations primarily through the use of teacher leaders. How did the district employ these teacher leaders to help classroom teachers implement Investigations? The purpose of this study is to understand how a district employed their teacher leaders to support fellow teachers in curriculum change.

Research Questions

The research questions from this study include: How do teacher leaders support fellow classroom teachers in the implementation of TERC's mathematics curriculum, Investigations? What different roles do teacher leaders play in supporting classroom teachers in implementing *Investigations*? How do teacher leaders use the knowledge gained at district-wide professional development programs for in-house staff development meetings at their school?

Background

TERC's Investigations reflect the recommendations for reform in mathematics as found in the National Council of Teachers of Mathematics (NCTM) Curriculum and Evaluation Standards for School Mathematics (1989), Professional Standards for Teaching Mathematics (1991) and Assessment Standards for School Mathematics (1995) (hereafter called the Standards). NCTM advocates that mathematics curriculum and instruction shift from an emphasis on computational and other traditional mathematics skills to an emphasis on enhancing students' mathematical thinking through active participation in constructing their own mathematical knowledge. This new classroom environment has students solving problems, reasoning, and communicating their ideas in mathematics. Teachers encourage students, probe for ideas, and carefully judge their students' understanding of the mathematical concepts. To empower all students to be competent mathematics thinkers, "teachers should be facilitating student construction of their [students'] own mathematical understanding" (Schifter, 1996, p.3). A mathematics curriculum should enable students to become mathematical problem solvers who can communicate and reason mathematically.

There are two dilemmas with using a standards-based curriculum, such as Investigations. One is that these curricula conflict with the way teachers have learned mathematics. Many teachers learned mathematics by a traditional teacher-centered approach where they were taught to use algorithms to solve mathematical equations without understanding why they were using them. Lortie (1975) observed that teachers teach in the same manner in which they were taught as

students, thus applying an "apprenticeship of observation." He also claimed that teachers were usually reluctant to try new teaching methods unless they felt sure of their success in teaching.

Another problem with implementing a standards-based mathematics curriculum is that most elementary teachers have an inadequate understanding of the mathematical concepts being covered in part because of the way they were taught (Ball & Cohen, 1995; Porter, 1991). An insufficient mathematical understanding leaves many teachers insecure in their ability to teach mathematics. Smylie (1988) claimed that teachers' sense of efficacy has the greatest influence on changing teachers' teaching practice. When teachers felt comfortable with their teaching and with their subject matter knowledge, they were more likely to try something different.

These issues associated with implementing a new standards-based curriculum are exemplified in the Springfield District*, a Northwest school district currently undergoing a mathematics curriculum change.

Conceptual Framework

The conceptual framework that informs this study represents the intersection of four arenas of education research: reform in mathematics education, professional development, teacher leadership, and educational policy and organizational contexts. I begin with a review of literature connecting elements of the standards-based mathematics curriculum Investigations to current reforms in mathematics education. I then present principles of effective professional development needed to implement a standards-based mathematics curriculum as supported by research studies. I then provide a descriptive framework of teacher leadership that will be used to examine teacher leaders in two elementary schools. The last section in this review of literature deals with educational policy and organizational contexts. It includes a discussion on policymaking and implementation theory and organizational theory. I believe these four arenas in education research are important because they provide lenses that will inform my analysis of the data on teacher leaders assisting in curriculum implementation.

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* A pseudonym

Mathematics Educational Reform and Standards-Based Curricula

Reforms in mathematics education have been an integral part of initiatives for school change and for higher standards for academic achievement, started by the Agenda for Action in 1981. The 1989, 1991, and 1995 Standards documents promote the idea that students should be actively engaged in doing mathematics in order to improve students' understanding of the concepts. A K-5 curriculum that reflects the Standards values children's intuitive mathematical insight and believes that learning mathematics is a sense-making experience. A mathematics curriculum developed for the first five years of school should take into consideration children's intellectual, social and emotional development. Children need a substantial amount of time to construct a foundational mathematical understanding and to develop the ability to reason and communicate mathematically (Mokros, Russell, & Economopoulos, 1995). The Technical Educational Research Center's Investigations of Number, Data, and Space reflect the recommendations for reform in mathematics as found in the NCTM Standards. The developers of the *Investigations* curriculum want students to:

a. construct their own strategies for solving problems instead of relying on memorized procedures and algorithms;
b. use a variety of manipulative materials and appropriate technology as part of their everyday mathematical experience;
c. express their mathematical thinking through different media such as oral communication, drawings or writing;
d. explore mathematical concepts in an environment where students can talk to their peers either as a whole class, in pairs, or in small groups;
e. use a variety of strategies and methods for learning a mathematical concept;
f. engage students in real world problems that require mathematics (TERC, 1998).

By setting these goals for the TERC's Investigations material, the authors have set out to align their curricular goals with the Standards (1989).

For the Investigations curriculum to be meaningful for students, the authors of Investigations advocate that teachers need to listen carefully to their students' conversations about the mathematics in order to make pedagogical decisions. Teachers need to learn and understand how their students are thinking and ask questions that will extend their students' mathematical reasoning (Russell, Tierney, Mokros, Goodrow, & Murray, 1997). NCTM (1989; 1991) calls for teachers: to provide opportunities for classroom discourse and for students to develop and explore mathematical concepts; to provide an atmosphere that promotes learning of, investigation into and enthusiasm for mathematics; to determine what students understand through listening to and probing students' thinking; to analyze and reflect on their teaching practice to insure that the best teaching practices are being used to reach all students. These two themes of effective teaching practices as seen in the Standards and TERC's Investigations are directly related to each other.

Teacher Leaders of Mathematics Reform and Curriculum Implementation

In order to understand the analysis of this study it is necessary to state my vision of teacher leadership of curriculum implementation in the context of mathematics education reform. However, it is also important to note that this is not the only area of mathematics education reform where teacher leadership can be employed. Teachers can also contribute as leaders in curriculum development and adaptation. Curriculum development is when teachers create specific lesson units to implemented in a classroom. Curriculum adaptation is when teachers adapt current curriculum materials to better meet the needs of their students (Loucks-Horsley et al., 1998). While these other forms of leadership are critical it is beyond the scope of this research project to examine the nature of teacher leadership in curriculum development and adaptation.

So what does it mean to be a teacher leader in mathematics educational reform and what does it mean to be a teacher leader in curriculum implementation? It is the assumption of this researcher that teacher leaders of mathematics reform are more familiar with the global and national concerns in mathematics reform. Teacher leaders of curriculum implementation are not only

concerned with the national and global aspects of mathematics reform but also with the local and particular aspect of implementing a standards-based mathematics curriculum.

Teachers who are leaders in mathematics educational reform are knowledgeable about the Standards and recent research on student learning in mathematics. They are conversant in the wider discourse of mathematics education. Teacher leaders in mathematics educational reform understand how to do hands-on activities that engage and push students' thinking. They are also sufficiently comfortable with the content knowledge to help students construct their own strategies for solving problems. Teacher leaders in mathematics educational reform use a variety of instructional strategies and methods to help students learning mathematics. With this understanding of the goals of educational reform and the ability to infuse effective teacher practices into their classrooms, teacher leaders are able to extend their knowledge to their peers through conversations and workshops or by example.

The same knowledge required of a teacher leader in mathematics educational reform is required of a teacher leader in curriculum implementation. The tools needed of a teacher leader in curriculum implementation are more particular to their situation. Teacher leaders in curriculum implementation understand the organizational culture of their school and district, and understand the needs of the students the curriculum is supposed to support. Many teacher leaders of curriculum implementation can call on their knowledge of mathematics reform to help their colleagues in understanding the curricula's goals, scope and sequence in an implementation situation. Teacher leaders of curriculum implementation are very confident and knowledgeable about mathematics so they can easily examine and learn the scope and sequence of the curriculum. By understanding the scope and sequence the teacher leaders can determine how the curriculum develops a mathematical concept and how it supports students' learning of that concept. They can make intelligent decisions about curriculum content and pedagogy in order to best support students' learning of mathematics. Teacher leaders of curriculum implementation can also provide professional development that help teachers understand the mathematics embedded in the

curriculum, the pedagogy that pervades the curriculum, and relevant issues related to implementing the curriculum successfully.

Fullan and Pomfret (1977) claimed that effective implementation of school reform consists of adopting new curriculum materials, modifying teachers' instructional practices and behavior, and changing teachers' beliefs and understanding of how students learn. Curriculum change in mathematics education is just one facet of school change. The adoption and implementation of a standards-based mathematics curriculum is not enough to change teachers' beliefs about teaching mathematics. Effective professional development is needed to change teachers' current beliefs on teaching and student learning, and enhance their understanding of mathematics (NCTM, 1989).

Professional Development

In mathematics education, teachers are being asked to teach for understanding, engage all students in mathematical investigations that have real world applications, and emphasize depth in mathematical thinking rather than superficial algorithmic knowledge (NCTM, 1989). However, a teacher cannot teach nor implement what they do not understand. Lortie (1975) observed, teachers are "reluctant to try new approaches unless they feel sure they can make them work and avoid damaging their reputation" (p. 234). By providing professional development opportunities that enhances teachers' content knowledge and pedagogical content knowledge, teachers will feel more comfortable and confident in trying to change their teaching practice (Smylie, 1988).

Several researchers (Fullan, 1991; Fullan & Pomfret, 1977; Huberman & Miles, 1984; Joyce & Showers, 1988; Wideen, 1992) ascertained that teacher development and successful implementation of innovative school change are interconnected. Several other researchers (e.g., Ball & Cohen, 1995; Fullan & Hargreaves, 1992; Porter, 1991; Wideen, 1992) found that plans for change within schools must be accompanied with professional development in order to change teachers' instructional and assessment practices and their beliefs in how students learn. As with student learners, researchers of effective professional development and school change have found that teachers need a learning structure similar to those advocated by constructivist learning theories

for students. Loucks-Horsley, Hewson, Love and Stiles (1998) claimed that a strong professional development program enables teachers to develop an awareness of new pedagogical approaches or content, build knowledge, translate new knowledge into practice, practice teaching what they have just learned, reflect and gather feedback on their new practice. This cycle enables teachers to re-inform their knowledge and therefore begin the cycle again.

Loucks-Horsley and her associates (1998) identified seven fundamental principles for providing effective professional development experiences for teachers. I have added an eighth principle as a result of the findings from this study. Because of the inductive nature of qualitative research, theoretical categories and propositions can emerge from the examination of the data; data that is grounded in the context of the study (Creswell, 1998; Merriam, 1988; Yin, 1994). In the following paragraphs, I discuss how these eight principles can be used by teacher leaders and school administrators who assist teachers in curriculum change.

Principles of Effective Professional Development

One, providing professional development opportunities that enable teachers to enhance their content knowledge and pedagogical content knowledge (Ball, 1996; Fullan, 1991; Little, 1982; Smylie, 1988). Teacher leaders can enhance teachers' instructional and content knowledge through inservice staff meetings (Little, 1982; 1988; 1990; Stone, Horejs, & Lomas, 1997). Teacher leaders can learn and understand their fellow teachers' practical knowledge of teaching and student learning, then develop strategies that will move teachers forward in their thinking of education reform. In-house professional development meetings are more responsive than district or corporate professional development programs in meeting the individual needs of the teacher and of the school. In-house professional development experiences therefore do not divorce themselves from the teachers' organizational context (Lieberman, 1987).

Two, implementing curriculum materials that present a well-defined image of effective classroom learning and teaching (Ball & Cohen, 1995; NCTM, 1989). By implementing curriculum materials that present a well-defined image of effective classroom teaching and learning,

teachers are better able to understand what they are being asked to do in the context of reform. Teachers can refer to the curriculum material for support in understanding of what types of changes are sought. They are better able to implement the vision of school reform because they have materials to reference. Without these curriculum materials teachers are left to their own interpretations of the reform efforts and corresponding curriculum (Cohen & Ball, 1990; NCTM, 1989).

Three, building a professional learning community (Leblanc & Shelton, 1997; Leithwood, 1992; Little, 1982). Teacher leaders can help create and sustain a collaborative and collegial professional learning community (Leblanc & Shelton, 1997; Little, 1982; Little, 1988; Stone et al., 1997). "When teachers are active participants in a professional community of their peers, they gain important knowledge and psychological support" (Adajian, 1996, p. 321). Schools, which have a strong sense of collegiality, believe that the continuous improvement of the school is a shared endeavor, that improvement in knowledge and teaching practices is a continuous process. In successful schools that sustained positive change, teachers valued and participated in "norms of collegiality," and continuously worked to improve their teaching practice. Teachers pursued a greater range of professional interactions with fellow teachers or administrators. This interaction included talking about instruction and shared planning (Little, 1982).

Four, establishing teacher leadership roles and supporting teachers in those roles (Berry & Ginsberg, 1990; Leithwood, 1994; Lieberman, Saxl, & Miles, 1988). By establishing teacher leadership roles and supporting teachers in those roles spreads the responsibility of leadership to more people who can then share their expertise and experience. Research on professional development and school change has shown that teacher leadership and teacher support are both required if there is to be any lasting and meaningful change in teaching and learning (Fullan & Hargreaves, 1992; Loucks-Horsley et al., 1998; Sikes, 1992). Sikes (1992) claimed that teacher leaders are the strongest link for transforming teaching practices because they offer local leadership and provide support mechanisms needed at the school level. Lieberman (1987) found that teacher leaders who work as mentors are able to take teachers from "where they are and work with them in

a collaborative fashion to expose them to growth opportunities, research and the best that is known about good teaching practice" (p. 402).

Five, integrating with other district and school initiatives and a supportive district and school administration (Heller & Firestone, 1995). Reform efforts and other district and school initiatives need to be integrated so as not to overwhelm teachers implementing change in several areas at once. The misalignment of school initiatives can impair teachers from making significant improvements to their teaching practice (Knapp, 1997). A supportive district and school administration that recognizes and values the work teachers are putting into the reform effort will positively impact teacher change so as not to undermine teachers' self-esteem and willingness to try new teaching methods (Stone et al., 1997; Wideen, 1992). Fullan (1991) argued that administrative and parental support is vital for successful school change.

Six, providing professional development experiences that use or model the type of teaching strategies teachers will use with their students (Fullan, 1990). Professional development experiences needs to use or model the same type of teaching strategies teachers will use with their students (Fullan, 1990). If we want instruction to be problem-based, student centered and concept building then the professional development experience must reflect that vision. Lortie (1975) found that most teachers teach as they were taught, thus applying an "apprenticeship of observation" (p. 61). By modeling effective teaching strategies, professional development facilitators provide teachers with an opportunity to apply a new, positive kind of "apprenticeship of observation."

Seven, assessing the professional development program continuously to ensure that teachers' needs are being met and a positive impact on student learning is taking place. Professional development programs need to continuously assess themselves to ensure that teachers' needs are being met and a positive impact on student learning is taking place (Whitaker, 1997). One way to do this is through the practice of reflection. Reflection is the act of examining one's practice to better inform future professional decisions and to be thoughtful and deliberate in meeting people needs.

Dewey (1933/1964) believed that reflection is a holistic way to examine and assess one's teaching practice. Schön (1983) advocated that reflection is the most powerful method for professionals to examine and reform their work practices. The goal of a reflective practitioner is to be proactive in their teaching rather than reactive because the act of reflection differentiates action that is routine from action that is purposeful.

Eight, building an infrastructure for change corresponds to changing organizational norms, structures and time allotment that enables teachers to work towards incorporating the previous eight principles into their work site (Fullan, 1991; Fullan & Hargreaves, 1992; Wideen, 1992). I will discuss issues related to organizational structure in a later section on educational context that includes policy and organizations.

These principles of effective professional development (Represented in Appendix A) should guide the experiences for any teacher in order to bring about change at their school. Teacher leaders who take an active role in influencing change can use these principles to bring about changes at their school. Teacher leaders who receive and provide professional development opportunities that incorporate these principles will help their fellow teachers move forward in the process of change so that everyone can feel comfortable changing their teaching practice. By understanding the principles of effective professional development assists in the analyzing of the support teachers leaders receive and the support they offer their fellow teachers.

Teacher Leadership

Teacher leadership and teacher professional development are inextricably linked (Personal Communication Portin, 2000). Researchers believe that one necessary element for successful and sustained change is to help teachers develop and serve in leadership roles (e. g., Fullan, 1991; Little, 1988; Loucks-Horsley et al., 1998; Sikes, 1992). Developing successful teacher leaders enables the creation of strong professional cultures that are essential for changing norms of teachers' teaching practices (Loucks-Horsley et al., 1998; McLaughlin, 1993; Talbert & Perry, 1994). With the plethora of school reform initiatives in the last five years, many school reform

policies have fallen to teachers in peer leadership roles to implement (Hargreaves, 1991; Hart, 1990; Little, 1995; Smylie, 1994; Whitaker, 1997).

In order to examine the nature of teacher learning in a teacher leadership model of professional development, a conceptual framework for the attributes of effective teacher leadership must be defined. This framework (See Appendix A.) made it possible to analyze and discuss the leadership roles of the teachers that I observed. Research on professional development and school change has shown that teacher leadership and teacher support are both required if there is to be any change in teaching and learning (Fullan, 1991). Teacher leadership enables schools to draw on their teachers' expertise and experience (Griffin, 1995; Heller & Firestone, 1995). Teacher leadership helps to promote a professional workplace, where the current hierarchical leadership structure gives way to a more democratic form of leadership (Little, 1995). Though the principal's role is crucial and should not be ignored (Fullan, 1991; Huberman & Miles, 1984), having teacher leaders allows power and authority to rest with more people. Leadership roles empower "teachers to assume greater responsibility in their professional work lives" (Stone, Horejs, & Lomas, 1997, p. 50). Finally, teacher leaders serve as a continuing and influential force in schools after the external professional development programs that correspond to the implementation of a standards-based curriculum end (Loucks-Horsley, et al., 1998).

If teacher leaders are to be effective in supporting teachers in curriculum change and mathematics education reform then they need to fulfill seven interdependent leadership roles synthesized from empirical and theoretical research. This list should not to be used as a checklist, rather as interconnected parts of a whole, where the whole is greater than the sum of its parts.

First, teacher leaders need to provide moral support and build a trusting atmosphere where fellow teachers can try new teaching practices (Lieberman, Saxl & Miles, 1988; Little, 1982; 1990; 1995; Stone, Horejs, & Lomas, 1997). Lieberman, Saxl and Miles (1988) found that the teacher leaders engaged other teachers in an open and supportive dialogue in order to earn teachers' trust, and then built a support workgroup for teachers so that they could come together and work.

Secondly, teacher leaders can provide administrative support by gathering needed resources and materials for teachers. For some teacher leaders this can mean becoming a "gofer," gathering needed manipulatives for a lesson, keeping track of the manipulative materials, getting needed textbooks for teachers and making sure that non-reusable equipment is reordered for the next year. Gathering resources can also include people and ideas that can enhance teachers' understanding of a concept or how students' learn mathematics (Heller & Firestone, 1995; Lieberman, Saxl & Miles, 1988).

A third aspect of teacher leadership is that teacher leaders need to work as liaisons between the district leaders, principals, and their fellow teachers by communicating each other's needs (Hart, 1990; 1994). Teacher leaders from one school in Hart's (1990) study enhanced the communication lines between the principal and teachers. To help strengthen communication within the school, teacher leaders relayed messages, asked questions of district leaders, collected needed information for the teachers, and connected teachers to administrators in the school community. Tichy believed, "a good transformational leader is a good communicator and/or understands the importance of communication within an organization" (Witherspoon, 1997, p. 63). The act of leadership calls for the dissemination of messages through verbal and non-verbal communication. In helping teachers move through the change process the ability to communicate, to establish trust and to respect among all participants in the school context will be paramount. As a teacher leader working towards change, having the school community think and talk about reform measures will be vital if there is to be any type of meaningful school change. The ability to get people talking and thinking about change requires an ability to communicate the need for change, and mobilize people to work towards change.

Fourth, teacher leaders need to help create and sustain a collaborative and collegial atmosphere (Leblanc & Shelton, 1997; Little, 1982; 1988; Stone, Horejs, & Lomas, 1997). Schools who have a strong sense of collegiality believe that the continuous improvement of the school is a shared endeavor, that improvement in knowledge and teaching practices is a continuous process. In successful schools that underwent change, teachers valued and participated in "norms

of collegiality," and continuously worked to improve their teaching practice. Teachers pursued a greater range of professional interactions with fellow teachers or administrators. This interaction included talking about instruction and shared planning (Little, 1982).

A fifth piece that Lieberman (1987) found was that teacher leaders who work as mentors need to be able to take teachers from "where they are and work with them in a collaborative fashion to expose them to growth opportunities, research and the best that is known about good teaching practice" (p. 402). However, being a mentor does not mean that teacher leaders take on and defend a position of good teaching; rather they model professionalism in teaching through "their own continuous inquiry, expanded repertoire, and high standards for what it means to be a teacher" (p. 402).

Sixth, teacher leaders should provide instructional and content knowledge support through inservice staff meetings (Little, 1982; 1988; 1990; Stone, Horejs, & Lomas, 1997). The process of curriculum implementation is a learning process for teachers and it takes time (Fullan & Hargreaves, 1992). It is important to recognize that teachers learn in the same manner that students do (Wideen, 1992). Teacher leaders can learn and understand their fellow teachers' practical knowledge of teaching and student learning, then develop strategies that will move teachers forward in their thinking on mathematics education. In-house professional development meetings are responsive to the individual needs of the teacher and of the school. Therefor professional development experiences would not divorce themselves from the teachers' organizational context needs (Lieberman, 1987).

Finally, the conception of leadership must go beyond a managerial role where teachers are completing duties and administrative tasks. If real and sustained change is to occur, then teacher leaders need to do more than just obtain equipment. We must let go of the image of a leader as a single person leading unquestioning followers through a static and one-directional communication link (Watkins, 1989). Instead we must think of leadership as enabling "others to reach their full potential. . . . Ultimately, this will mean empowering others to take over the reins of leadership

when these others are most suited for the task" (Bottery, 1992, p. 181). This form of shared leadership I will refer to as transformational leadership.

Transformational leadership occurs when one or more people engage other people so that they raise each other "to higher levels of motivation and morality" (Burns, 1978, p. 20). Through transformational leadership a group of people are "presently or potentially united in a pursuit of 'higher' goals, the realization of which is tested by the achievement of a significant change" (Burns, 1978, pp. 425-426). Transformational teacher leaders in curriculum change help motivate and elevate teachers" thinking and execution of their teaching practices.

A transformational teacher leader in mathematics education systematically critiques the previous and current conditions of mathematics teaching, then actively reflects and honestly assesses their teaching practice for its strengths and weaknesses. A reflective mathematics teacher leader therefore is able to develop a vision of the future of mathematics teaching based on an examination of the past and present; a vision that leads to the development of better mathematics instruction. Foster (1989) claimed that if leaders are both reflective and transformative agents when engaged in leadership, then they are also educators. When teachers share leadership and challenge each other intellectually then the school becomes a learning community (Blase & Roberts-Blase, 1994). Also, an effective teacher leader develops over time and every teacher has the potential to be a leader. As in teaching, successful leadership is learned, practiced and reflected upon (Lambert, 1995).

The term leader is a 'loaded word' in teaching because of the egalitarian nature of the profession, but the role of teacher leader can be seen as an influence agent or a change agent at the school or district level. When transformational leadership is a shared endeavor all teachers take on the leadership when it is needed for them to do so. Transformational leadership among teachers becomes more egalitarian and reflects the teaching professions' organizational culture.

As important as teacher leadership is to the successful implementation of curriculum change, it puts teachers in the strange position of being simultaneously both the subject and agent of change (Sikes, 1992). Both district leaders and teacher leaders need to realize the fragility of

change and people working towards change. District leaders need to appreciate the awkward position their teacher leaders are in and teacher leaders need to see the difficulty in changing one's teaching practice. Therefore, both leaders need humility, compassion and understanding for those working towards change (Starratt, 1993).

Educational Contexts

Teacher leadership and professional development cannot be fully understood without first examining how policies and organizational structure impact the school community and school change. School reform initiatives and various policy implementations take place within the context of a school organization. Organizational context impacts, interferes and influences change. In this section, I explore the connections between policies and organization structures that impact teacher leaders' work as change agents.

Policy

Over the years, educators have seen many different reform initiatives come and go. These reform policies failed for the most part because they lacked a cohesive unifying vision, or were executed with a top-down administrative approach. Teacher acceptance and commitment to the proposed changes may have been nearly non-existent, or professional development to help teachers understand the changes they were being asked to make to their teaching practice was meager (Ball, 1990; Cohen, 1990; Cohen & Ball, 1990). To understand how policies are implemented at the school level, one must examine how teachers work as agents of policy (Schwille et al., 1986). How teachers implement policies critically depends "on their knowledge of and beliefs about academic subjects, for that knowledge and those beliefs mediate teachers' capacity to understand policy and respond to it" (Ball & Cohen, 1995, p. 8). What teachers understand about reform initiatives has a considerable affect on what they offer students and therefore what students are able to learn (Cohen & Ball, 1990).

> Adopting instructional strategies that emphasize meaning typically means that teachers must fundamentally rework their conceptions of the subject they are teaching and their approaches to it. Mandating changes without giving teachers considerable professional support and the flexibility to adapt the mandate to their particular circumstances can often be counterproductive. In such instances, many teachers become confused and embark on new approaches without understanding them, resulting in ineffective teaching (Knapp et al., 1995, p. 181).

Knapp (1995) defined policy as "a purposeful course of action by individuals at higher levels in the system designed to guide, direct, or support actions at lower levels of the system across settings, and across time" (p. 2). Knapp, Shields and Padilla (1995) defined three types of policies that directly impact what is taught in the classroom and how it is taught. They are curriculum policies, assessment policies and professional development policies. The teachers participating in this study are impacted by each of these three types of policies. Curriculum policies define what content is taught. These curriculum policies can specify learning requirements, graduation requirements, or particular curriculum materials. Assessment policies specify what aspects of teaching and learning are assessed and measured, and how those measurements are used. These assessment policies can hold schools, districts and educators accountable for student learning and achievement.

Professional development policies address teachers' needs for continued learning related to their teaching practice. The standards-based reform movement asks teachers to dramatically change their teaching practice by relinquishing teacher-centered direct instruction and drill-and-practice memorization for student-centered, inquiry-based instruction (Wirt & Kirst, 1997). To be successful in helping all student master more challenging material, teachers need deeper pedagogical and content knowledge (Ball & Cohen, 1995). The knowledge required for teaching for understanding increases the difficulty of changing teaching practices. Professional development policies' goals are to address this deficiency in teacher knowledge.

Teachers and teacher leaders from the Springfield School District, who participated in this study, were told to use TERC's *Investigations* for the elementary mathematics curriculum. The adoption and implementation of *Investigations* is seen as a curriculum policy. A curriculum policy that was the result of a state wide assessment policy ESHB 1209. ESHB 1209 holds schools and districts accountable for improving students' scores on the state's assessment on student learning (Commission on Student Learning, 1997). The professional development policy is represented by the district use of a teacher leadership model of professional development to assist in implementing the curriculum policy of using TERC's *Investigations* in the elementary classroom.

Elmore and Sykes (1992) named four types of policy implementation processes. The first type mandates or commands change through requirements and directives from administrative positional authority. There is a great temptation for educational leaders who hold top leadership positions to use mandates as the principle strategy for achieving policy goals-- to command teachers to change what they teach and how they teach it. However, research suggests (see Ball, 1990; Cohen, 1990) that such mandates are unlikely to achieve the policy goals. The second type of policy implementation, an inducement, invites change by offering resources and assistance through grant programs that encourage or entice change. The third type, capacity building, uses staff development to provide resources and assistance to teachers or assist them by creating a supportive environment to help them in the change process. The fourth type, systemic change, initiates and integrates school change initiatives at both the school or district site. It involves site-based management that empowers and engages teachers to change by moving decision-making authority to the school site (Knapp, 1997).

Springfield school district employed mandates and capacity building processes as the means for policy implementation. The curriculum policy to adopt TERC's *Investigations* began as a mandate from the superintendent in the spring of 1997. In the fall of 1997, they began providing regularly occurring professional development to their elementary mathematics teacher leaders. These teacher leaders were charged with disseminating information about the *Investigations* curriculum and assisting teachers in implementing the new mathematics curriculum. From 1997 to

2000, professional development opportunities were also provided for all elementary school teachers during summer breaks, after school programs and twice during the academic school year.

Organizations

The challenges that any initiative faces when it moves into the schools are untrained teachers, confused parents and organizational structures that resist change (Wirt & Kirst, 1997). To understand how organizations work one must realize that organizations are not a place, they are an "interactive process through which individuals order ideas, experiences, and events, socially constructing shared meanings to facilitate individual, group and organizational goals" (Witherspoon, 1997, p. 46). It is impossible to modify an organization without impacting the people who are part of that organization (Greenfield, 1973). Because organizations can dictate the success or failure of school reform, it is of paramount importance to understand the organizational structure.

Within an organizational context teacher leaders can facilitate change but they will also have to react to issues and disturbances (Heller & Firestone, 1995). Organizational components affecting teacher leadership performance are school structure, culture, climate, and the resources available (Witherspoon, 1997). Data analysis of teacher leaders work as change agents needs to consider these organizational components as mediating factors in their success and challenges.

Research Methods

This study was conducted using qualitative research methodology, specifically using a descriptive case study design. Merriam (1998) described case studies as a design that "is employed to gain an in-depth understanding of the situation and meaning of those involved" (p. 19). Data were collected from two teacher leader and classroom teacher pairs from Douglas Elementary School* and Pyne Elementary School* in order to produce an in-depth understanding of the different ways in which teacher leaders support classroom teachers in the implementation of a

* A pseudonym.

standards-based mathematics curriculum. Interviews and observation served as the primary tool of data collection. All interviews were audio taped with the participants' permission.

I selected schools that exhibited best case scenarios in order to examine what roles teacher leaders would embody. I asked the mathematics specialists at the district to recommend two elementary schools that fit the following criteria: (a) the principal was supportive of the new mathematics curriculum; (b) the principal had attended all the professional development meetings offered by the district; (c) teachers described the school as having a team-like atmosphere; (d) teacher leaders were described as eager to try new ideas and open to change; and (e) teacher leaders were also described as comfortable doing mathematics. Douglas Elementary School and Pyne Elementary School were suggested as possible schools in which to study teacher leadership and their work with classroom teachers.

The data consist of (a) participant observation field notes of the district's professional development meetings attended by teacher leaders, (b) observation field notes of the teacher leaders' district meetings focused on the Investigations curriculum, (c) semi-structured interviews with four teacher leaders, two from each school, (d) semi-structured interviews with four classroom teachers from the grade cluster that the corresponding teacher leader represented, and, (e) documented data of newsletters and memos sent from the mathematics specialists to Springfield Elementary teachers related to TERC's mathematics curriculum.

Data Collection

Observations were used to gather descriptive information on what was happening at the professional development workshops offered by the district. My goal was to understand what the teacher leaders experienced and learned as participants in these workshops and to see how that was translated to the school site.

I interviewed teacher leaders in hour-long, semi-structured interviews at the school site. Such semi-structured interviews allow the interviewee to respond at length to the interviewer prompt and enables the interviewer to expand and further explore themes or topics as they become

apparent in an interview. The semi-structured interview still provides enough structure so as not to lose sight of the relevant issues (Patton, 1980). I used a list of questions during the interview to serve as a guide to assure that all the relevant issues were discussed.

For the interviews with teacher leaders, I asked open-ended questions related to the adoption and implementation process of Investigations and the means by which teacher leaders were supporting fellow classroom teachers in the implementation of TERC. (See Appendix B.) For the interviews with classroom teachers, I gathered information pertaining primarily to the adoption and implementation process of TERC's Investigations. I asked how classroom teachers felt they were being supported in the implementation of TERC. I also gathered information on how the district's professional development meetings for math leaders were translated to the school site. (See Appendix C.) I interviewed a corresponding classroom teacher from each represented grade cluster in order to corroborate the teacher leaders' perceptions of how they were supporting their fellow teachers, and learn how classroom teachers perceived they were being supported by the teacher leaders in the implementation of Investigations.

The interviews were transcribed and an index to the transcription was created (Yow, 1994). This index lists recurrent themes that surfaced during the interviews and where to find them in the transcript. Observation field notes were recorded in a field notebook and transferred into a typed computer file (Huberman & Miles, 1993). These field notes also have a corresponding summary.

The documented data consisted of district newsletters sent to all elementary teachers from the district's mathematics specialists. Because the professional development workshops would not be replicated in any fashion at the school, I wanted to learn what information the mathematics specialist was providing to teachers. I also collected memos sent from the district's executive directors proclaiming a variety mandates pertaining to the implementation of TERC's Investigations.

Limitations

The scope of this study is limited to the perceptions of four teacher leaders and four classroom teachers from two schools in one school district. Case study methods do not lend themselves to generalizations to other elementary schools in the district, or other elementary schools in Washington State. However, case study methodology allows me to add depth and breadth to existing literature on teacher leaders and school change. Any claims are qualified by the fact that teachers volunteered to be in this study. Some prospective participants chose not to be a part of this study due to time issues and lack of interest in the project.

Data Analysis

Analysis began with reading the interview transcripts to identify recurring themes. These themes were based on the roles teacher leaders employed to support classroom teachers in the implementation of the district's new mathematics curriculum. A coding scheme was developed by examining each thought unit and underlining the central point from the statement. I then returned to those underlined passages, wrote marginal notes about the main ideas of the statement, and finally created a coding scheme that reflected the common themes found throughout the data. I also asked a participant to review the content of my findings and conclusions for verification. She concurred with the results. (Glaser, 1969; Glesne, 1999; Merriam, 1988; Miles & Huberman, 1994). (See Appendix D.) These themes include: teacher leaders providing administrative support, teacher leaders being a conduit for communication between district leaders and school staff, differential perception on time issues from teacher leaders at each school, and the impact of simultaneously implementing new curricula for other content areas.

To insure the anonymity of the participants, classroom teachers received a one-syllable pseudonym. Teacher leaders were assigned two-syllable pseudonyms and the principals received three-syllable pseudonyms.

Context

Teacher Leadership Model of Professional Development

Springfield's mathematics teacher leaders, curriculum leaders and superintendent decided in the fall of 1997 to adopt TERC's Investigations to strengthen their district's elementary mathematics program and align the elementary curriculum with the district's previously implemented standards-based middle school mathematics curriculum. Until 1998-99, this school district's elementary school teachers were given considerable autonomy over their classrooms' mathematical content and instructional practice. The mathematics curriculum specialists advocated for the use of Marilyn Burns' replacement units (Correspondence, June 1999) but teachers only requirement was to cover a given number of topics by the end of the school year with whatever text materials they wanted to use. In the fall of 1997 this district, which has a reputation for strong academic achievement, received disappointingly low-test scores on the state's new mathematical assessment of student learning, otherwise known as the WASL. To improve their test scores, the superintendent mandated that the whole district move to one coherent mathematics curricular program that reflected the state's Essential Academic Learning Requirements (EALRs). In response, district administrators and teacher leaders selected TERC's Investigations.The Springfield district employed teacher leaders at each school to support elementary teachers during the implementation of TERC's Investigations. In 1998, the district created teacher leadership teams in order to provide staff development in a cost efficient manner and get important information about the curriculum to the teachers. Three teacher leaders and their principal from each school participated in professional development programs offered over the course of the academic school year. Teacher leaders were chosen by their principals or volunteered for the position. Each teacher leader represented a K - 1, 2 - 3, or 4 - 5 grade cluster.

The school district also provided optional summer and after school workshops for all the elementary school teachers. Attendance at these workshops is by choice and teachers received reimbursement pay for their time. However, the district required that teachers spend 28 hours participating in compensated professional development programs each academic school year, so many teachers use these mathematics workshop opportunities to fulfill the district's professional development requirements. For those elementary school teachers who do not attend these

mathematics workshops, the main avenue for staff development on TERC's Investigations was through their teacher leaders or at the all day grade level mathematics staff development meetings offered twice a year. According to the curriculum specialists at Springfield district, teacher leaders were seen as communicators between district leaders and classroom teachers. They were also seen as facilitators of in-house professional development experiences related to TERC's Investigations material.

Douglas Elementary School

Douglas Elementary School is an ethnically diverse school with a 49 percent minority student population. Forty-four percent of their students receive free or reduced lunch. In 1997, the first year the Washington Assessment on Student Learning (WASL) was given, fewer than 10 percent of their students performed at or above standard for mathematics. In 1999, more than 30 percent of students performed at or above standard. In the last three years with the arrival of Margaret, the school principal, the school has gained the reputation around the district as having a strong and productive collegial atmosphere. Sue, a 3 - 4 grade teacher, asked to transfer to Douglas last year because of the school's recent reputation.

After some initial turbulence following the adoption of the TERC mathematics curriculum, the school's staff members came together to work out problems before the curriculum implementation took place the following academic year. Both teacher leaders from Douglas Elementary School felt the principal was instrumental in creating positive attitudes towards the new mathematics curriculum. After the decision to adopt TERC's Investigations was made public, the principal asked the district's mathematics specialists to provide inservice workshops to understand TERC's Investigations. Two staff meetings were devoted to examining the scope and sequence of the new mathematics curriculum led by one of the curriculum specialists. At these meetings, teachers were able to vent their frustration over the adoption process, get answers from district leaders to their questions, and examine the new mathematics curriculum for its content and cross grade level spiraling effect. All four teachers interviewed for this study believed that this action by

the principal helped facilitate the implementation of Investigations at their school compared to the implementation process at other schools in the district.

The two teacher leaders participating in this study from Douglas, Karen and Lois, had been teaching for less than four years and in district for less than two years. As relative newcomers these teacher leaders stand in contrast to the literature on the characteristics of teacher leaders. Brownlee (1979), for example, characterized teacher leaders as having more years of teaching experience, teaching in the current school longer and having more formal education than the other teachers. Sue and Anne were the corresponding classroom teachers for Karen and Lois. Sue has been with the district for 12 years and Anne was in her second year of teaching.

Pyne Elementary School

Pyne Elementary School has over 500 students of whom 80 percent are European-American, and fewer than 10 percent receive free or reduced lunches. WASL scores of students at Pyne have increased since 1997, but only by five percentage points to the 45 percent level. The school has a reputation of collegiality among the staff members. Even though the school has had a new principal every year for the past five years, teachers have not requested transfers to other schools. In the turmoil of changing principals the faculty at Pyne Elementary decided to apply for a grant from the Northwest Initiative for Teaching and Learning (NWIFTL) so that they could focus on in house professional development opportunities that were developed and led by teachers in the school.

NWIFTL is a local initiative that provides grants to schools in order to examine best practices in teachers' professional development as a way to improve student learning. Schools participating in the grant write a proposal explaining why they want it, what it will be used for, and how the school will assess improvement in student learning. The focus of Pyne's grant is improving student learning through professional development by increasing teacher knowledge about important issues in teaching and learning, showing how assessment informs instruction, and recognizing the relationship of school culture and community with student achievement. NWIFTL

schools are responsible for creating a portfolio for an evidentiary trail to document the grant impact on teacher learning and student learning. The school can choose anything they want to investigate in their professional development meetings; Pyne Elementary focused on mathematics during the academic year 1998-99.

With the NWIFTL grant, Pyne Elementary created a cyclical model of professional development. Each cycle consisted of three meetings developed by the staff to meet their needs. The first meeting of a cycle focused on examining a new issue in teaching mathematics. The teachers left that first meeting with tasks to take back to their students. The teachers collected student work around that issue and brought it back for a second meeting. At this second meeting, they discussed their experiences about the task, looked at their students' work and determined what they had learned as teachers from the experience and what the students had learned. The teachers went away with more tasks to investigate in the classrooms and then came back for a third session of debriefing activities. In the course of the year, the teachers at Pyne Elementary met for three cycles of NWIFTL professional development meetings. They restructured their school schedule so that the school day was extended by a half-hour four days a week, making an early dismissal one day a week. All the teachers interviewed thought this worked well for them because when they met to discuss issues for NWIFTL or in other school meetings, they were fresh and not exhausted from teaching seven hours that day. Both mathematics leaders interviewed for this study, Laura and Kathleen, were on the NWIFTL committee that developed these cycle inservice meetings. At the beginning of the study I did not know that Pyne Elementary had this grant, but it became apparent that it would be an important factor in the school's conception of leadership and professional development.

Table 1. List of Participants

Pseudonym	Responsibilities	School
Anne	2 - 3 Classroom Teacher	Douglas Elementary School
Karen	4 - 5 Teacher Leader	Douglas Elementary School

Lois	2 - 3 Teacher Leader	Douglas Elementary School
Sue	3 - 4 Classroom Teacher	Douglas Elementary School
Margaret	Principal	Douglas Elementary School
Kathleen	K- 1 Teacher Leader	Pyne Elementary School
Laura	4 - 5 Teacher Leader	Pyne Elementary School
June	K - 1 Classroom Teacher	Pyne Elementary School
Pam	4 - 5 Classroom Teacher	Pyne Elementary School
Helen	Mathematics Curriculum Specialist	District Office
Judy	Mathematics Curriculum Specialist	District Office

Springfield District Governance Structure

The district's leadership style has changed dramatically since the hiring of the new superintendent. The previous superintendent supported site based management as the leadership and decision making structure. Under the current administration, more decisions are being made at the district office. The teachers interviewed felt that though the new superintendent sought the opinions and ideas of teachers and other district leaders, decisions for change have been delivered as mandates. Though the mathematics curriculum was the only official curriculum adoption, teachers perceived other curriculum changes as mandated implementations during the last academic year. Springfield district adopted a new literacy curriculum and was concurrently working to adopt a new science curriculum, which also makes use of teacher leaders. The teachers in this district also felt bombarded by the requirements of state reform efforts as put forth by the Essential Academic Learning Requirements (EALRs) and preparing students for the WASL.

Mapping to professional development framework

The professional development experiences offered by the Springfield school district for the mathematics teacher leaders reflected many of the principles of effective professional development set forth by Loucks-Horsley et. al., (1998). The district provided six full days of professional

development opportunities that enhanced teachers' content knowledge and pedagogical content knowledge. Teacher leaders at these workshops also examined what does it means to teach mathematics effectively and discussed important current issues in mathematics education.

The professional development meetings provided by the district for teacher leaders modeled the type of teaching strategies teachers were expected to use with their students, which were those advocated by NCTM (1991). The workshop had hands on mathematical activities where teachers solved problems from the Developing Mathematical Ideas professional development curriculum Building a System of Tens (1999). Teachers were asked to confront their current beliefs about how students effectively learn mathematics. Activities included in some of the workshops had teachers read and discuss the latest articles on mathematics teaching. For example, Deborah Ball's (1997) article From the general to the particular: Knowing our own students as learners of mathematics, was used as a discussion piece in understanding how to make pedagogical decisions based on what students say and do mathematically in their classrooms. The recently released Draft of the Standards 2000 was used as a reference in discussing what is meant by "problem solving" and whether TERC's Investigations support the notion of problem solving as advocated by NCTM. As a results of these recurring professional development meetings with the mathematics teacher leaders, a professional learning community developed among the teacher leaders that reached across schools within the district. Implementing TERC's Investigations gave the district a curriculum that presented a well-defined image of effective classroom teaching and learning. TERC's Investigations is considered exemplary by the National Science Foundation, Northwest Regional Educational Laboratories and NCTM. The creation of teacher leadership roles to help with the implementation of the new mathematics curriculum also reflects one of the principles for effective professional development and the curriculum specialist continually asked teachers and teacher leaders for feedback on how to best to support them in this process. The principle of integrating curriculum change with other school, district and state initiatives was violated but remaining true to this principle was made difficult by the district's need to respond to the demands of the state's assessment exam.

Findings

Given the context and the professional development provided by the district the following paragraphs describe the different ways in which teacher leaders at Douglas Elementary and Pyne Elementary support their fellow classroom teachers in the implementation of TERC's Investigations. Findings are presented in four major categories. These categories include: administrative support, conduit for communication, time constraints differences, and multiple curriculum changes simultaneously implemented. In general, these findings suggest that teacher leaders are not leaders, in a complete sense; rather, they complete managerial or administrative tasks and are used as communication links. However, when they were supported in developing and administering professional development experiences for their own school staff, teacher leaders became instruction leaders as well managerial leaders.

Teacher Leaders Providing Administrative Support

Providing administrative support for classroom teachers was the predominant role teacher leaders employed. Teacher leaders gathered and organized manipulative materials and curriculum texts for teachers, and they collected assessment pieces from each curriculum unit for the district's executive directors. They also gathered other needed supplies just as Lieberman, Saxl, and Miles (1988) found in their study. Karen, the teacher leader for the 4th-5th grade team, offered a response that was typical of the teacher leaders at this school. She explained:

> We got together and basically housed everything—inventoried materials. If the teachers need it; they come to us; fill out a form and we basically say, 'Okay you have this material for x amount of days.' So that way if anyone else needs it, we have a check of where things are. . . .So that's one part of it, the other part is the assessment piece. There are two assessment pieces of every unit. . . . They [teachers] pick out the students [assessments]. They give it to us. They fill out a form on how many kids got it, how many kids kind of

> got it but need some help—the third category is they definitely need more help. So that way we can keep track of what students are falling through the cracks.

Sue, a corresponding 4-5 classroom teacher, substantiated Karen's claim by saying,

> One staff meeting we actually had it where a lot of the math materials are kept. And the math team went through on the shelves and said, 'If you need this it's here. You might not know that we had the plastic money.' As so we were able to visually scope out what the inventory of materials were. So I thought that was really helpful.

Lois also talked about her role as a teacher leader:

> [There are] a couple of different facets to [the leadership role]. We—in the very beginning of the year our biggest focus was—it sounds kind of dumb but to get all the materials organized, because all of a sudden we were inundated with boxes, boxes, boxes and boxes of materials for all the different units. Organizing them and putting them in bins, and labels —those kinds of things. We developed a check out system, a form for each unit, for teachers to give us when they need materials. Because we wanted to be able to keep track of where they were and have them returned. So that's one thing we have done as a teacher leader group and then I've been in charge of the assessments. . . . We need to be sending the assessments in to the district. So kind of keep tabs on the different teachers and where they are and what units and if they haven't turned in the assessments in.

At Pyne Elementary, Laura talked about her clerical duties as a teacher leader. She described how when she got all the material she had "to figure out who got what." Other duties included gathering assessments for the mathematics specialists and if someone needed some type of manipulative materials she would try to find it.

All four teachers leaders saw the necessity of making sure that the administrative tasks were attended to throughout the school year. Obtaining needed resources is an important job, without gathering the requisite materials the actual work of implementation would be thwarted because first order needs would not be met and therefore higher order needs would never be addressed or

achieved. Heller and Firestone (1995) claimed that one of the six essential functions of leadership is gathering needed materials.

Teacher Leaders as the Conduit for Communication

Teacher leaders helped to enhance communication links between district leaders and classroom teachers. Whenever teacher leaders had information to share out to other teachers in the school, all four teacher leaders repeated that they would either make announcements at staff or team meetings, mention something during informal conversations during the day, or send out e-mail to the staff. All four teacher leaders talked about getting information out and relaying information back to the district leaders as a common theme. Laura described how she shared information about the district inservice meetings to her staff:

> If we were having a staff meeting then we might say, 'You know we were at a math leader meeting and' —I might share out in my 4-5 team. I might be sitting with them on a Wednesday afternoon and say, 'All right I was just at math leaders and you need to know that it's okay to skip —If you can't get to it, then you can leave out Data About Us, that unit. If you're having a hard time getting through another unit...what we've talked about was that this is what you should do' . . . . It's just kind of the nuts and bolts run through; any important messages that need to come back to the staff and if there's any information that needs to go back to Helen [mathematics specialist] then bring it back there. Or it might happen at a staff meeting. 'All right we were all at a math leader meeting last week this is what we did, this is what we learned.' Just to give a really quick synopsis of it to other people so they get a feel for what we've done when we've been out of the building. News, simple news most of the time.

Kathleen, the K-1 teacher leader from Pyne Elementary, told how her primary job was "more or less relating back to the teachers what we do in the teacher leader meeting." Karen talked about getting information to teachers about materials and the latest news:

> When it affects the whole group whenever we come together as a whole Margaret [principal] always reserves one part for us. And we say, 'Materials are down there come see us. This is what's going on.' When it's a specific grade level, it's more this is what so-and-so said regarding using your old lessons or your own curriculum to support TERC.

Lois talked about the need to relay information back and forth between classroom teachers and the district's mathematics curriculum specialists. "If somebody asked me a question that I need to ask the [curriculum specialist], I ask them and get back to [the teachers] right away so people feel like they aren't in the classroom by themselves trying to figure all this out." Sue mentioned how she gets the information from the math teacher leader meetings:

> During staff meetings Margaret [principal] gives them time to share, they've used email. . . . there are minutes or highlights of what went on at the math leader meetings that are sent out to all of us. So we hear what has gone on. . . . . basically it's a tell.

Anne, the corresponding 2-3 classroom teacher, talked about the formal and informal information flow. "Sometimes it's at lunch, I'll be talking about something and they'll say, 'oh they talked about that [at the last district meeting] and [the mathematics specialists] said this.' Sometimes it's at the staff meetings they tell us what happened at the last district meeting."

A lack of communication can be the downfall of any type of movement towards change. Having people knowledgeable about the vision of the future or the plan for obtaining that vision creates a community that can achieve that vision. Communication is another fundamental requisite to the achievement of higher order goals. Those higher order goals are the enhancement of teachers content and pedagogical content knowledge and self empowerment through shared leadership.

Teachers' leadership role added to an already "fullplate"

The issue of time constraints combined with the teachers' typical dislike of being away from the classroom for the district's leader meetings also appeared as a common theme in the teacher leader interviews. Karen talked about more time as being the one thing she would want. "[O]n top of doing your own lesson plans and all the teaching, and then you have to worry about

getting at someone else's assessments, organizing them, sending them off." Laura explained how being a mathematics leader can be ill-timed:

> there's no planning when someone's going to need some help on something or when an order of materials is going to come in. So sometimes it can interfere with what you're doing in your own classroom. I mean taking time away from planning for your own kids [in order] to take care of some of their needs.

Teacher leaders, classroom teachers and the principal believed they had enough work with all the other reform measures currently going on in the district. Classroom teachers received the information about the professional development meetings the teacher leaders attend in the form of a tell-report during staff meetings, but time for such reports was not always allotted. When I asked to attend the next bi-monthly staff meeting at Douglas I was told not to bother going because they would be talking about earthquake preparedness. When I asked Anne about the upcoming once a month team meeting she said it would focus on the literacy program. I later asked Sue how long it took for information to reach her about the meetings the math teacher leaders attended, she said it sometimes takes a "couple of weeks." Every teacher felt overloaded with the need to address the EALRs and WASL in every aspect of their teaching. Since students were held responsible for achieving a standard competency rating on the assessment, teachers keenly felt the pressure to help students do well on the WASL. Teachers looked forward to the time when things would calm down.

Differences in the issue of time—Building an infrastructure for change

When I asked the teacher leaders what they would want, if they could have anything to help them in their leadership role, both teacher leaders from Douglas responded with the need for more time. Lois said:

> More time. . . . Maybe, again I would have to leave my class, a day of release time that's not a meeting, that we could accomplish some of the things that we want to accomplish. . . To have time with just the other teacher leaders to implement stuff for the other teachers. . .

whether it's gathering things together and organizing something, or typing something up for them, reflections, or doing some of those extra things. And then the other part is some more time carved out of our staff meeting to share.

When I asked both teacher leaders from Douglas when they planned to reproduce the professional development meeting in their own school, they replied that they hoped to do something about that next year. These in-house professional development meetings that the teacher leaders are supposed to provide for their fellow classroom teachers on using TERC's Investigations never occurred. They never had a set time in which to meet and discuss issues pertaining to Investigations.

This was a complete contrast to Pyne Elementary School. Every month Pyne's faculty met to discuss issues in mathematics education during the time set aside by the NWIFTL grant. For the 1998-1999 academic year teachers explored questions related to problem solving and writing in mathematics. Other areas they examined were how to balance teaching computational skills with having students develop their own strategies for computational skills. They also discussed issues related to intensity of time required for students' gaining conceptual understanding and balancing that will the need to cover all learning objectives from the state's EALRs. Pam, a classroom teacher at Pyne Elementary, said that "NWIFTL gave us time and paid us for focusing on math. It gave us a goal and focus. We are accountable to them to show how we used the money, so it gave us a whole school direction. So almost all the inservices were on math, which is TERC." Pam continued on to describe a NWIFTL inservice, "I can remember working on problem solving tasks, and learning from another teacher . . . just some step by step help on how to best help kids to learn how to read a problem and answer the questions. And we focused on how to write math explanations."

By structuring time to meet monthly to talk about issues related to teacher mathematics teachers at Pyne were able to articulate and find solutions to the dilemmas that result from using TERC's Investigations in the context of their classroom. The NWIFTL grant also had teacher buy-in for participating in these in-house professional development meeting because teachers self

selected to be part of this grant that required professional development participation at the school site. In contrast the teacher leaders at Douglas saw time as their biggest obstacle in moving beyond their managerial role as teacher leader. Providing instructional support was an impossible idea to obtain without the structured time meet.

Connections to the Conceptual Framework on Teacher Leadership

The teacher leaders at Douglas Elementary supported classroom teachers in three of the seven possible leadership functions that were described in the conceptual framework: providing administrative resource support; enhancing the communication between district leaders, principals and classroom teachers; and sustaining a collegial, collaborative atmosphere. That they did not provide instructional and content knowledge support or develop mentoring relationships may be explained by lack of time and resources to meet and talk about mathematics and Investigations. The mathematics leaders at Pyne Elementary, who were provided time and resources through a grant, were responsible not only for resource support and enhanced communication but, also, for providing instructional and content knowledge support, and develop mentoring relationships with teachers. The leadership aspects of providing moral support and building trust could not be substantiated through the data I collected. Additional study following teacher leaders and classroom teachers in the field setting may help to discover how those aspects of the leadership role may enter into the work of these teacher leaders.

Conclusion

Teacher leaders felt a tension between fulfilling administrative support duties and wanting to provide instructional support as leaders. Teacher leaders' roles in curriculum change, as the Springfield district has defined it, reflected descriptors for a middle management position rather than active leaders of change. Their primary responsibility was to handle resources and other managerial tasks such as relaying information to other teachers. The new curriculum required extensive manipulative materials to accompany each lesson. Teacher leaders are required to

maintain the manipulative materials and keep track of who is using them. They were also required to collect assessment data on student learning for district files. These teacher leaders did not perceive themselves as leaders, only as teachers who serve on a committee performing required duties. These duties required teacher leaders to participate in the district's professional development program, pass on needed information to their fellow teachers, and communicate teachers' needs to the district office. This is consistent with the description of teachers' tasks in Smylie's and Denny's (1990) study. However, if teacher leaders are used only as a middle-managers to complete managerial tasks, then how teachers think about teaching mathematics will be less likely to change.

The teacher leaders at Douglas are not complete leaders but managers due to the limited arsenal that is being call on, they are fulfilling an administrative support role that is tagged on to an already full load of teaching responsibilities. Completing needed tasks is an important job as we saw in Lieberman, Saxl and Miles' (1998) study. However, it does not even begin to transform how teachers think about teaching mathematics. As it stood in 1998-1999, how teachers understood the mathematical pedagogy involved in teaching TERC's Investigations was left to whatever the curriculum materials provided.

At Pyne Elementary the role of teacher leader was combined with the role of professional development workshop leader. As a result, teacher leaders and classroom teachers took ownership of their learning about the new mathematics curriculum and its relation to issues in mathematics educational reform and student understanding of mathematics. The teacher leaders provided workshops that reflected the needs of the school staff. Even though teachers at both schools claimed a strong collegial atmosphere, Pyne Elementary teachers were able to create a professional learning community that reflected on their teaching practices and participated in a dialogue about effective teaching and learning in mathematics.

District leaders also need to set aside time and provide structures for teacher leaders to lead —that is to provide professional development experiences that transform instructional practices and enhance teachers' content knowledge in mathematics at their schools. Teachers' professional

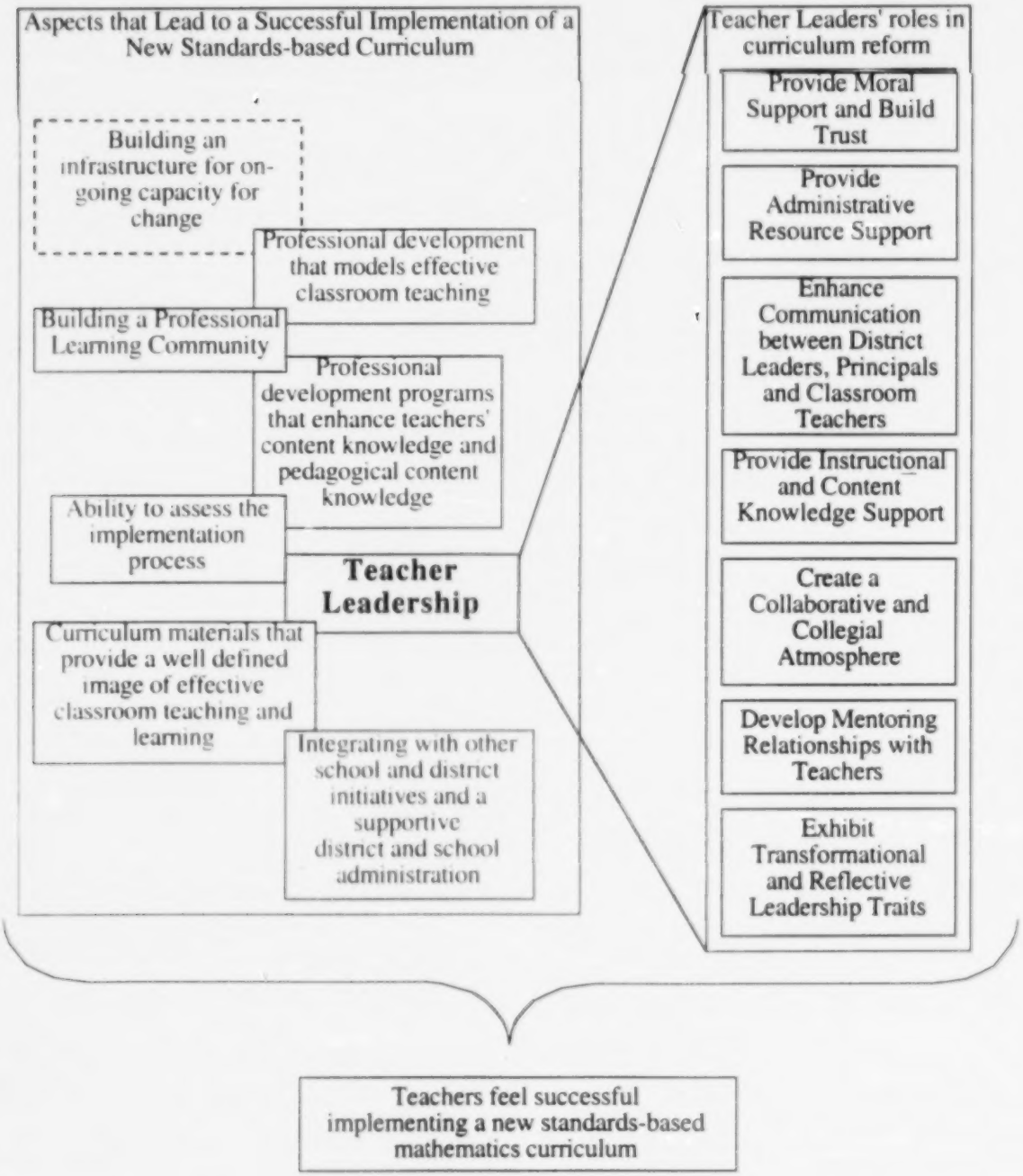
development leadership and learning opportunities are diminished when they are tacked on at the end of the day when teachers are tired.

Implications

Findings from this study can be useful to those involved with professional development programs and initiatives at the district level about the "pedestals and pitfalls" involved in adopting a K-5 mathematics curriculum reform model, such as TERC's Investigations materials. These findings suggest the need to think carefully about the multiple roles of teacher leader as a lever for change in the process of curricular reform. School districts throughout Washington State are struggling with the issue of raising student performance to meet standards on the state's new assessment in mathematics. Many students have received below standard scores and school districts are responding by looking to adopt a curriculum that incorporates Washington State's EALRs. To implement a new mathematics curriculum, thousands of dollars are spent. If there is to be any effect on student learning, then the curriculum must be understood and implemented successfully by teachers. By providing structured time, support and a forum where professional development needs matched professional development experiences elementary teachers can be more articulate about the teaching of reformed mathematics.

This article is one part of an on-going study that examine the nature of teacher leadership in curriculum implementation. This study examined the roles of teacher leaders in curriculum implementation in comparision to a theoretical conceptual framework. The second half of this study examines how the interactive link between teachers and teacher leaders is fulfilled in a teacher leadership model of professional development. Other questions that are being examined in a continued study are: How do teacher leaders influence classroom teachers' implementation of TERC's Investigations? How are classroom teachers implementing TERC's Investigations in comparison to what the teacher leaders are doing in their classroom?

Appendix A
Conceptual Framework


Aspects that Lead to a Successful Implementation of a New Standards-based Curriculum
Building an infrastructure for on-going capacity for change
Professional development that models effective classroom teaching
Building a Professional Learning Community
Professional development programs that enhance teachers' content knowledge and pedagogical content knowledge
Ability to assess the implementation process
Teacher Leadership
Curriculum materials that provide a well defined image of effective classroom teaching and learning
Integrating with other school and district initiatives and a supportive district and school administration
Teacher Leaders' roles in curriculum reform
Provide Moral Support and Build Trust
Provide Administrative Resource Support
Enhance Communication between District Leaders, Principals and Classroom Teachers
Provide Instructional and Content Knowledge Support
Create a Collaborative and Collegial Atmosphere
Develop Mentoring Relationships with Teachers
Exhibit Transformational and Reflective Leadership Traits
Teachers feel successful implementing a new standards-based mathematics curriculum

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Appendix B

Guiding Questions for Teacher Leaders

1. How would you compare TERC's Investigations to your previous mathematics curriculum?
2. Describe the work relationships that exists at your school.
3. Does the principal support you in the implementations of TERC? If yes, how? If no, how would you like them to support you?
4. Does the district supporting you in the implementation of TERC? (Superintendent, Math Specialists) If yes, how? If no, how would you like them to them to support you?
5. How were you chosen to be a teacher leader?
6. Tell me about your role as teacher leader in the implementation of TERC. Are there other aspects of the leadership role that you think are important?
7. What do you enjoy about being a teacher leader? What do you dislike about being a teacher leader?
8. What do you do to support teachers in the implementation of TERC?
9. Tell me about a situation in which you feel you had a positive impact on a fellow teacher with using TERC.
10. Tell me about a time in which you struggled to help a fellow teacher with using TERC -What did you do?
11. Describe what happens at the Marilyn Burns professional development programs offered by the district. How does it help you in the implementation of TERC? How do these programs help your fellow classroom teachers in implementing TERC?
12. Describe what you do at your school's staff development meetings that are focused on TERC.
13. If you could have anything to help you in the teacher leader role, what would you want?
14. Who do you feel is responsible for helping teachers understand the mathematics involved with teaching TERC?
15. How are you balancing your leadership role with you other duties?
16. Was your role of teacher leader clearly defined? In what way?

17. Do you see yourself as a leader of curriculum change?

18. How would you describe a leader?

19. Has being a teacher leader changed your working relationships with other teachers?

Appendix C

Guiding Questions for Classroom Teachers

1. Describe the work relationships that exists at your school.
2. Does the principal support you in the implementations of TERC? If yes, how? If no, how would you like them to support you?
3. Does the district supporting you in the implementation of TERC? (Superintendent, Math Specialists) If yes, how? If no, how would you like them to them to support you?
4. Who do you feel is responsible for helping teachers understand the mathematics involved with teaching TERC?
5. Describe what happens at the Marilyn Burns professional development programs offered by the district.
6. How does it help you in the implementation of TERC?
7. How does it model the type of classroom teaching TERC envisions?
8. Describe what happens at your school's staff development meetings that are focused on TERC.
9. In what ways has it helped you in implementing TERC?
10. Do you feel supported by teacher leader in the implementation of TERC? If yes, How? If not how would you like to be supported?
11. If you could have anything to help you in implementing TERC what would you want?

Appendix D

Coding Scheme

1. Administrative Support: This refers to performing clerical duties such as gathering assessments for district leaders, organizing manipulatives and materials, passing out and keeping track of manipulatives and materials, or handing out textbooks.

ADMIN-SUP/ASSESS
ADMIN-SUP/ORGAN MANIP
ADMIN-SUP/TRCK MANIP
ADMIN-SUP/TXTBKS

2. Communication: This refers to teacher leaders role of relaying information back and forth to teachers and district leaders. This also includes relaying information gathered at the district's professional development meeting for teacher leaders.

COMM/FRTCHR-TODSTLDRS/UNFRML
COMM/FRDSTPDM-TOTCHRS/FRML
COMM/FRDSTLDR-TOTCHRS/FRML
COMM/FRDSTPDM-TOTCHRS/UNFRML

3. Moral Support: This refers to teacher leaders acting as moral supporting agents. Acting as a cheerleader. A teacher leader who listens to other teachers' fears, problems and frustrations. Is conscious of how other teachers are doing with respect to TERC. Seeks out how other teachers are doing.

MRLSUP/LSTN
MRLSUP/SKGTCHR
MRLSUP/CHRLDR

4. Overload: This refers to teachers concern with implementing several curriculum changes at once. TERC takes a lot of time to read and be prepared to teach and compound that with their other teaching/leadership duties. Teachers are feeling the crunch of doing too much at once. Teachers worry other things are being sacrificed.

OVRLD/TMEPREP
OVRLD/OUTSDUTIES

OVRLD/TMEOTHCURRIC

5. NWIFTL: This refers to the Northwest Initiative for Teaching and Learning. It is an initiative that provides grants to examine and improve student learning through in house staff development programs. The grant buys teachers' time to meet and discuss issues in teaching that are important to them. This grant supports teachers in examining their teaching practice and examining student work to gain understanding of what their students do and do not know. Teachers have to provide and evidentiary trial to show how the grant is impacting student learning.

NWIFTL/CONCEPT
NWIFTL/CYCLE
NWIFTL/TCHRINPT
NWIFTL/SCHSCHED
NWIFTL/TPCS
NWIFTL/TIME
NWIFTL/FOCUS
NWIFTL/EVIDNC

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